Intrinsic Defects in Wide Bandgap Semiconductors: Study by Magnetic Resonance Techniques I

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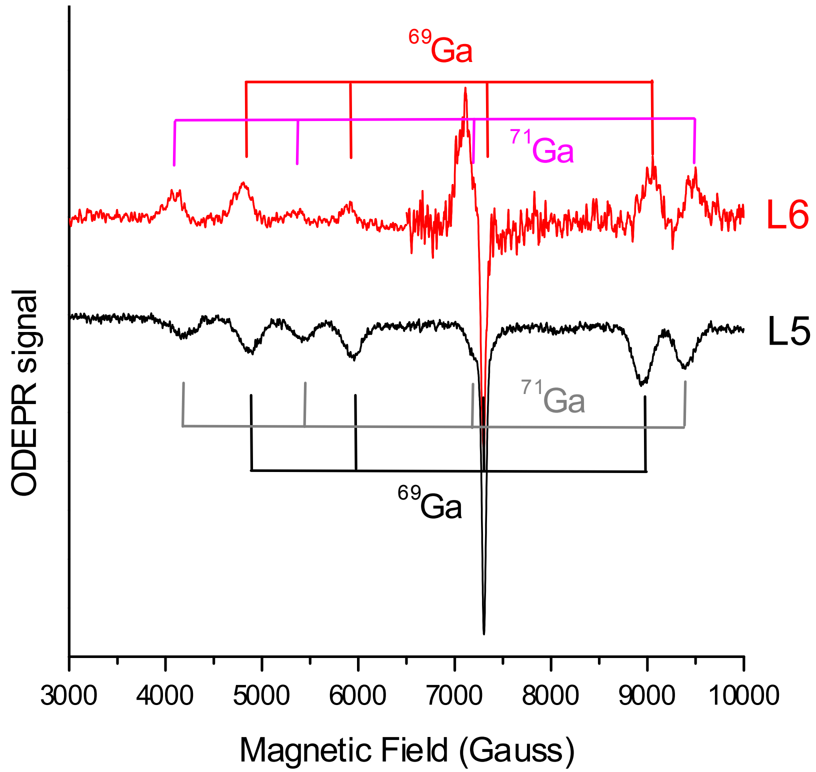
Gallium Nitride. Essential to the successful fabrication of electronic and optical devices from this exciting new material, is the understanding of its *intrinsic defects* (lattice vacancies and extra interstitial atoms), which control many of the vital processing steps. Until this study, nothing was known.

Interstitial gallium has now been detected and identified after production by 2.5 MeV electron irradiation *in situ* at 4.2 K. As shown in Fig. 1, *two distinct configurations are detected*, L5 and L6, each identified by the characteristic four-line EPR spectrum for its two natural abundant isotopes as a change in the luminescence intensity of the material as the magnetic field is swept through resonance for its electronic spin.

The two configurations are stable upon annealing to room temperature, at which point *they become mobile* and disappear. This high mobility for an intrinsic detect in such a robust, high temperature, material has come as a surprise to most materials scientists.



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A further surprise!

Immediately after defect production by the electron irradiation, only L5 is observed. However, as shown in the figure, prolonged illumination at 1.8 K by near bandgap light (364 nm) causes partial conversion to L6. Recovery is also observed as the intensities of both decrease. This suggests that

L5 and L6 arise from the two available interstitial configurations (T and O) in GaN!

Motion between them represents a half-diffusion jump. The observed recovery can result therefore as the interstitial migrates and finds the nearby Ga vacancy from which it was originally displaced in the production event. Therefore,

electronic excitation can cause the interstitial to migrate even at 1.5 K!

This surprise may have serious consequences for possible degradation of devices made from GaN.

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